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AD-A227 478

High Sea State Ambient Noise Near Bermuda

A Paper Presented at the
112th Meeting of the Acoustical Society of America
8-12 December 1986, Anaheim, California

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PREFACE

This document was prepared under NUSC
Project No. 710Y11

REVIEWED AND APPROVED: 25 February 1987


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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE			Approved for public release; distribution is unlimited.	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NUSC TD 7917			5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Naval Underwater Systems Center		6b. OFFICE SYMBOL (If applicable) 3331		7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code). New London Laboratory New London, CT 06320			7b. ADDRESS (City, State, and ZIP Code)	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Naval Underwater Systems Center		8b. OFFICE SYMBOL (If applicable) 10		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) New London Laboratory New London, CT 06320			10. SOURCE OF FUNDING NUMBERS	
			PROGRAM ELEMENT NO.	PROJECT NO. 710Y11
			TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) HIGH SEA STATE AMBIENT NOISE NEAR BERMUDA				
12. PERSONAL AUTHOR(S) William A. Von Winkle, David G. Browning, and A. Donn Cobb				
13a. TYPE OF REPORT Summary		13b. TIME COVERED FROM TO		14. DATE OF REPORT (Year, Month, Day) 1987 February 25
15. PAGE COUNT 10				
16. SUPPLEMENTARY NOTATION A Paper Presented at the 112th Meeting of the Acoustical Society of America, 8-12 December 1986, Anaheim, California				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Ambient Noise	
			Storm Noise	
			Wind-Generated Noise	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The observed relationship between wind speed and ambient noise level has varied from ocean to ocean. Generally higher levels measured in southern hemisphere oceans have been attributed to fully developed seas, although this mechanism is not understood. Ambient noise data taken near Bermuda after a persistent (5 days) wind of approximately 40 knots are higher than previously observed and consistent with southern ocean measurements, thus supporting a developed sea state hypothesis.				
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL David G. Browning			22b. TELEPHONE (Include Area Code) (203) 440-4173	
			22c. OFFICE SYMBOL 3331	

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.
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HIGH SEA STATE AMBIENT NOISE NEAR BERMUDA

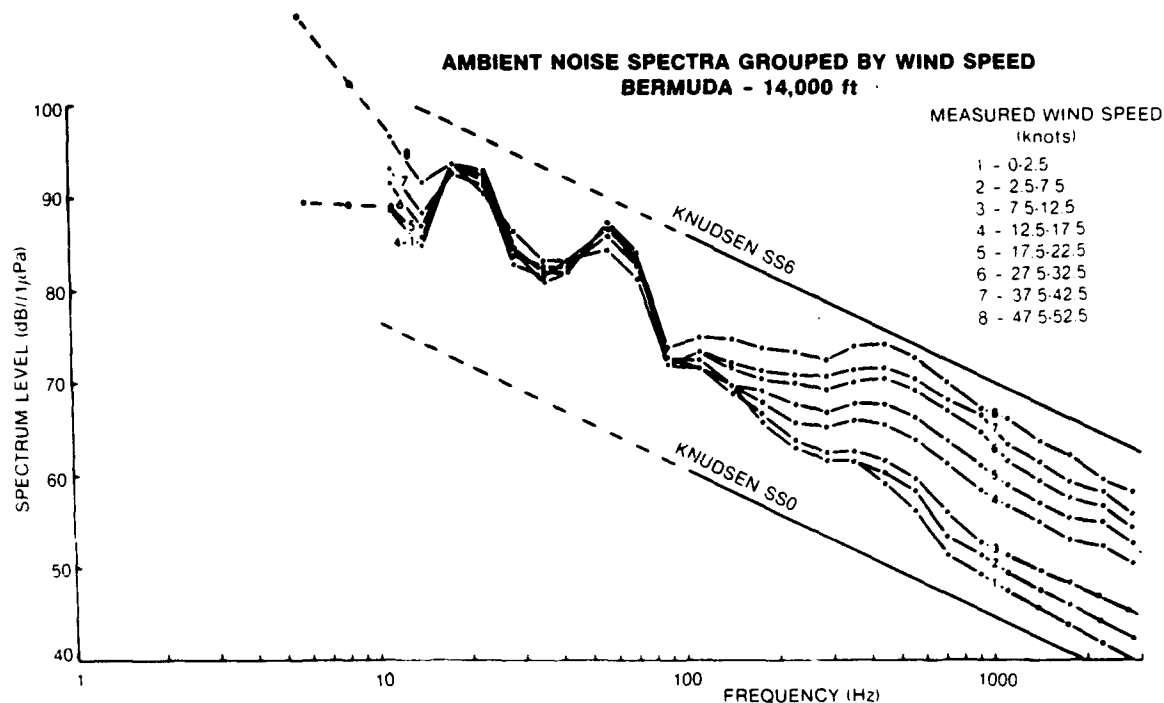
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VIEWGRAPH 1

To develop standard noise curves for performance prediction models, we need to know the characteristics of all noise components over a wide frequency range. At present, one of the least known components is wind-generated noise between 10 and 200 Hz. Specifically, does a distinct noise mechanism exist, as suggested by Isakovich and Kur'yanov, between the well documented bubbles and spray at higher frequencies and the very low frequency mechanism (microseisms) reported by Kibblewhite?

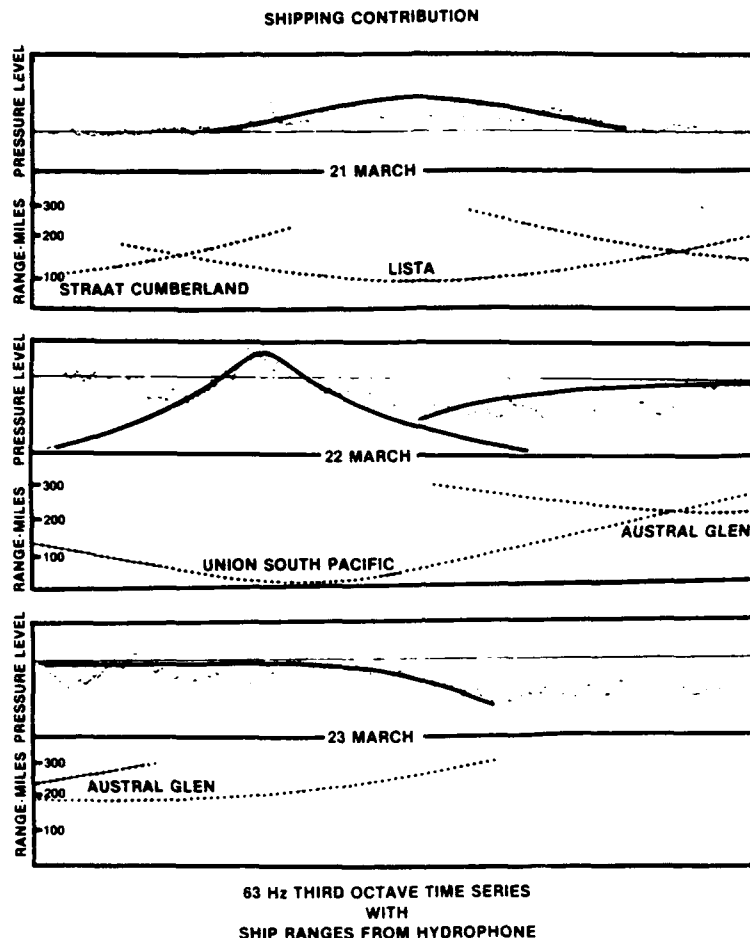
We will present some limited but unique data recorded near Bermuda to try to answer this question.



VIEWGRAPH 2

The difficulty of measuring wind-generated noise in the 10 to 200 Hz range for the heavily trafficked oceans of the Northern Hemisphere is illustrated by these classic data curves of Perrone.* Attempts by other investigators to circumvent this problem by choosing isolated locations or measuring below the critical depth have been meaningful but not definitive.

*A. J. Perrone, "Ambient-Noise Spectrum levels as a Function of Water Depth," Journal of the Acoustical Society of America, vol. 48, no. 1, 1970, pp. 362-370.

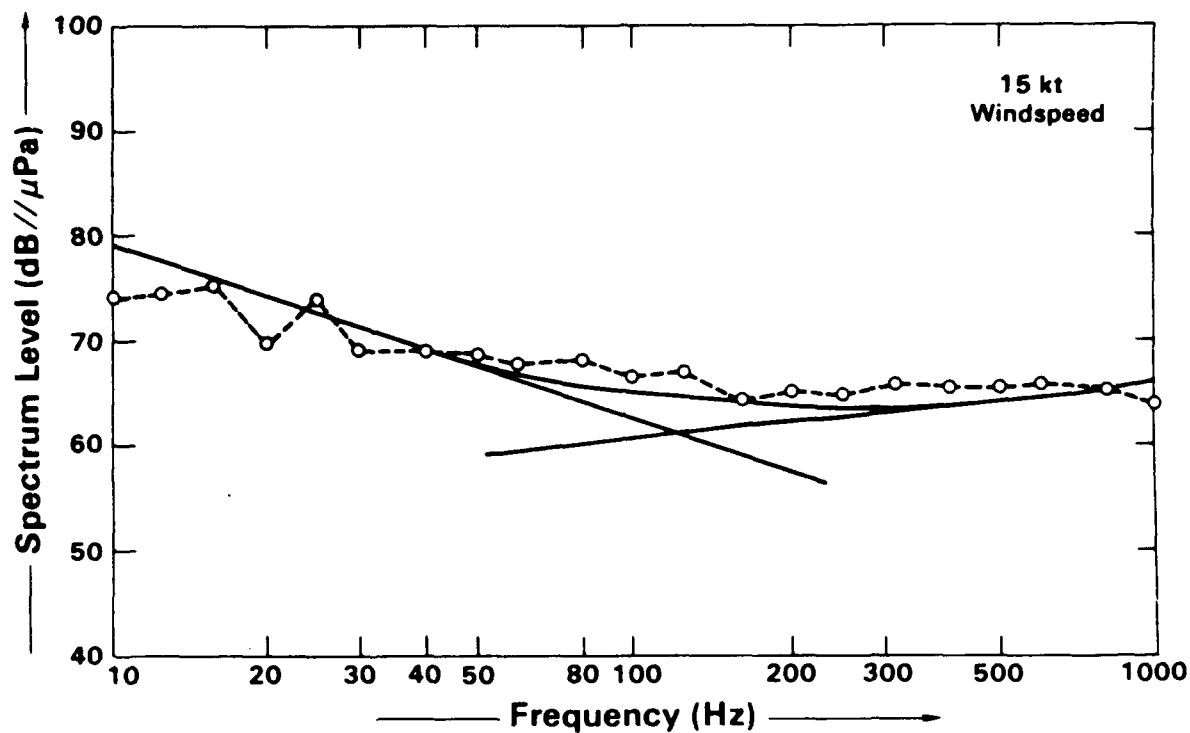


VIEWGRAPH 3

Recent work in Southern Hemisphere Oceans by Australian and New Zealand investigators has shown, as expected, a reduced level of shipping noise.

Typical data from the Fiji Basin reported by Bannister et al. indicate that the shipping noise can, in many cases, be attributed to single ships. It is possible to find limited time segments when pure wind-generated noise can be measured in the 10 to 200 Hz region.

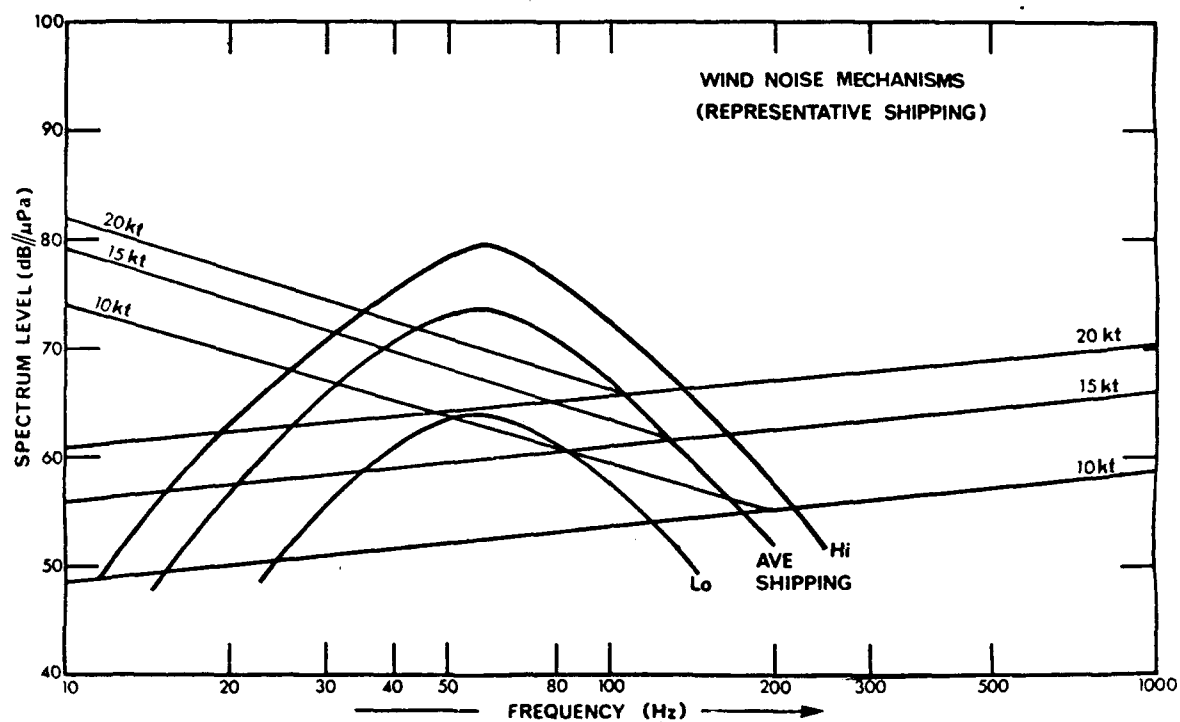
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VIEWGRAPH 4

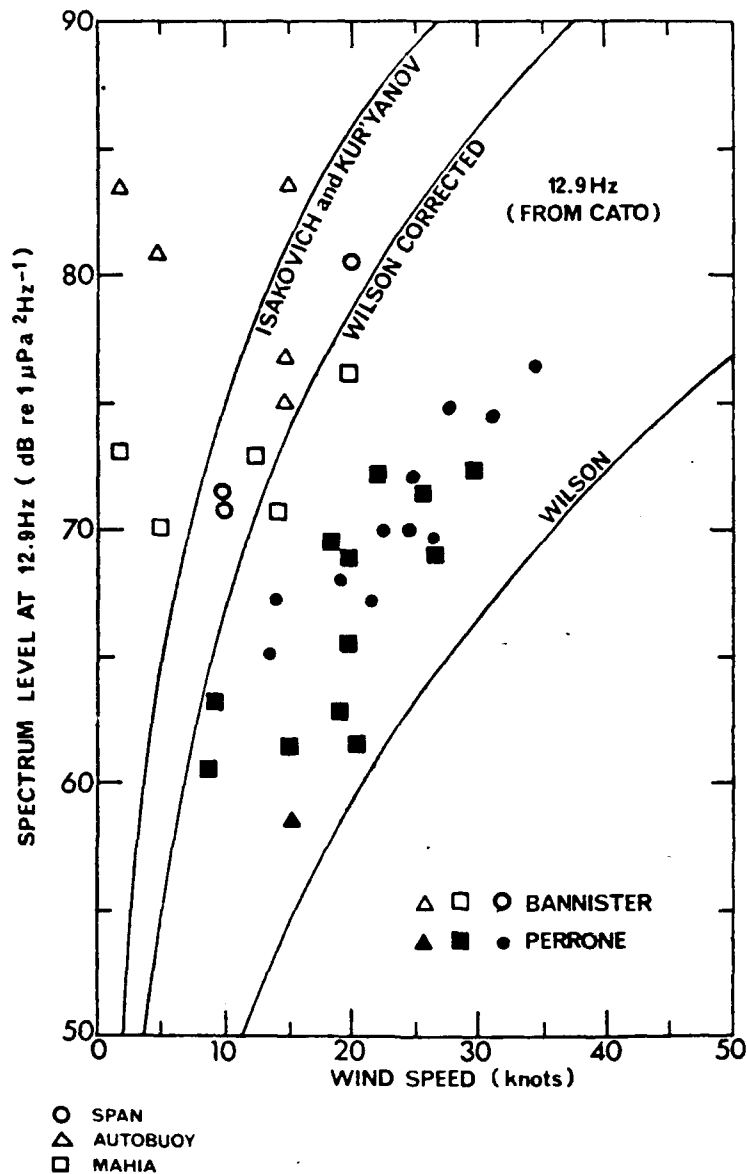
Bannister and Browning found that wind-generated noise taken in the Fiji Basin showed no apparent roll-off below 200 Hz as would be expected for the bubbled and spray mechanism alone.

A reasonable fit to the data could be obtained using Wilson's curve for bubbles and spray above 100 Hz and the Isakovich-Kur'yanov curve below 100 Hz. All were for a 15-knot wind speed.



VIEWGRAPH 5

Combining these two mechanisms with shipping noise curves would provide a basis for standard noise curves. Note that, as published, Wilson's bubbles and spray noise curves did not turn downward above 300 Hz as might be expected. I believe that has been incorporated in later developments.

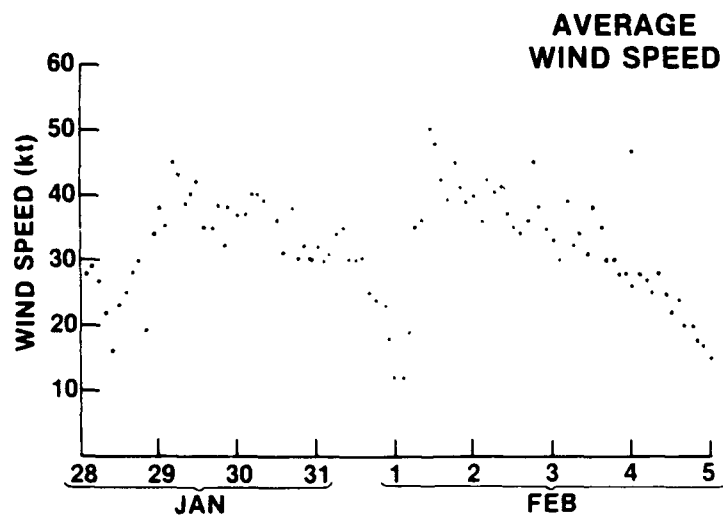
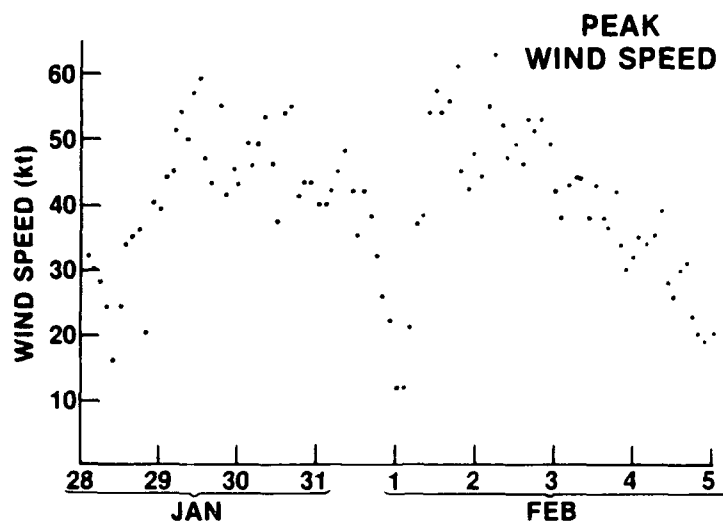


VIEWGRAPH 6

Despite the shipping contamination, Perrone did observe a wind-dependence of ambient noise near Bermuda at his lowest frequencies near 10 Hz.

However, for a typical frequency of approximately 13 Hz, these data were not in agreement with the Isakovich and Kur'yanov theory. As observed by other investigators, the noise levels measured in Northern Hemisphere oceans are generally lower than those measured in the Southern Hemisphere for a given wind speed.

It has been suggested that this may be because of more fully developed sea conditions in the Southern Oceans.



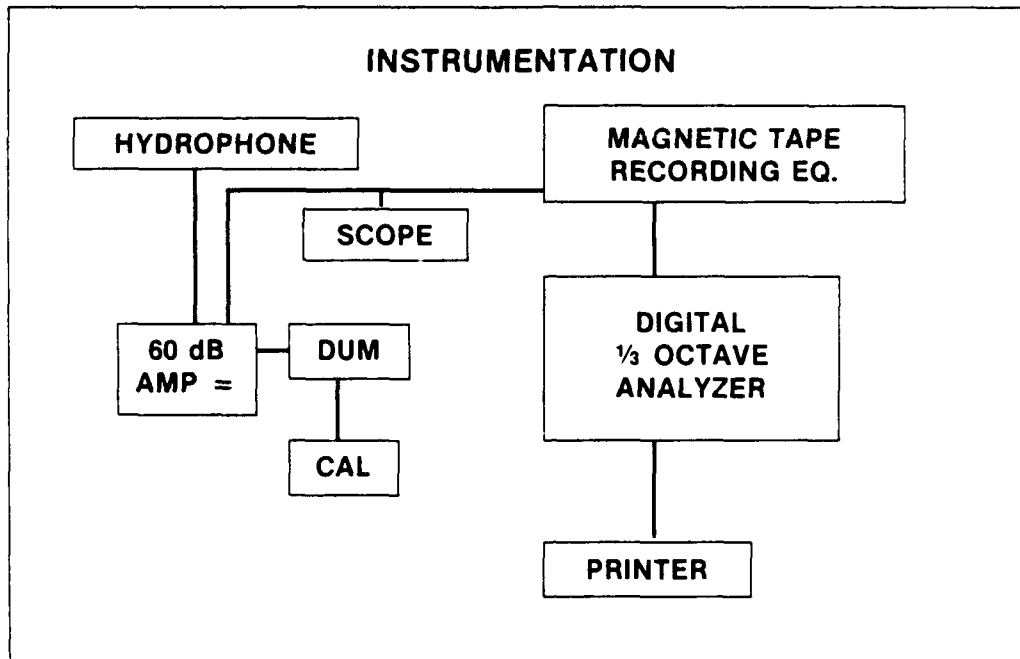
VIEWGRAPH 7

We therefore looked back to determine if we had any low frequency ambient noise data taken at Bermuda when there was a very high wind speed (in order to overcome shipping noise levels) which had persisted for a significant length of time to allow the sea to become fully developed.

Fortunately, we found some previously unreported data that were taken during an unusually severe winter storm several years ago.

Peak winds of over 60 knots were recorded and the wind averaged approximately 40 knots for about a week.

BERMUDA AMBIENT NOISE MEASUREMENT



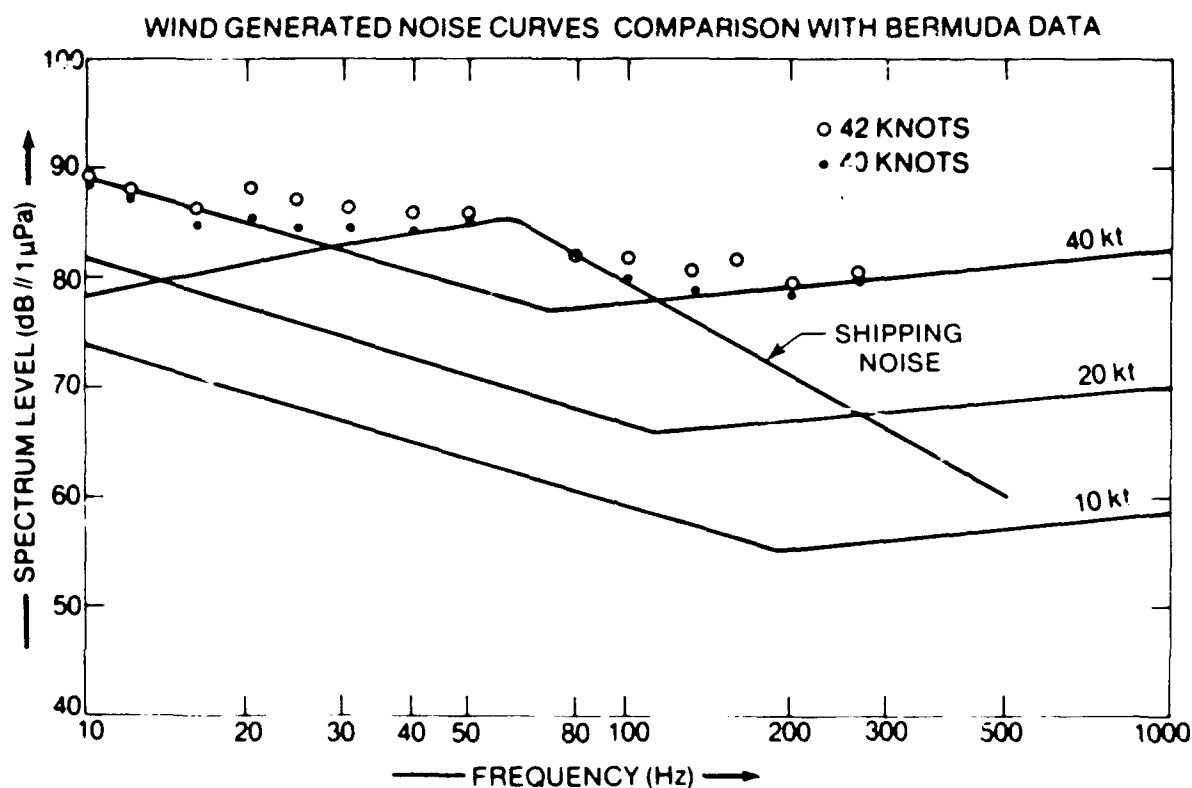
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VIEWGRAPH 8

Data were prepared from a bottom mounted hydrophone in 3 kilometers of water. The sound speed profile under these winter conditions was not bottom-limited.

The recordings were then processed through a 1/3-octave digital analyzer to obtain levels from 10 to 250 Hz.

The data were integrated over a 15-minute period and then averaged.



VIEWGRAPH 9

Results are shown here for 40 (dark circles) and 42 (open circles) knots and are compared to the noise curves developed from the Southern Ocean data.

You can see that even at these high wind speeds, shipping noise still dominates part of the spectrum.

Below 60 Hz, however, it appears that the data support the Isakovich and Kur'yanov noise curves. Above 80 Hz the data also blend into the bubbles and spray curves as given by Wilson.

CONCLUSIONS

- DATA SIMILAR TO SOUTHERN OCEAN RESULTS
- SUGGESTS SEA DEVELOPMENT A FACTOR IN NOISE LEVELS
- LONG TERM DATA COLLECTION REQUIRED

VIEWGRAPH 10

In summary, the limited amount of persistent high wind speed ambient noise data that we have from the Northern Hemisphere seems to be compatible with the Southern Ocean results.

This suggests that sea development is a factor in noise levels and that the Isakovich and Kur'yanov theory is required to predict wind generated noise levels in the 10 to 200 Hz region.

Finally, we are all trying to squeeze out the most we can from the short data samples we have but there is no escaping the fact that long term data collection is essential.